Active Project

Near Earth Asteroid Scout Project

Advanced Exploration Systems Program | Human Exploration And Operations Mission Directorate (HEOMD)

ABSTRACT

The Marshall Space Flight Center (MSFC) and Jet Propulsion Laboratory (JPL) are jointly examining a potential mission concept called ‘Near Earth Asteroid (NEA) Scout,’ utilizing a low-cost platform such as CubeSat in response to the current needs for affordable missions with exploration science value. The NEA Scout project will analyze, design, develop, and fly a controllable and instrumented solar sail spacecraft capable of rendezvousing with and then surveying a Near Earth Asteroid (NEA). This solar sail spacecraft (or sailcraft) will be small enough to qualify as a secondary payload on the Space Launch System (SLS) Exploration Mission-1 (EM-1) mission. The primary purpose of this mission is to demonstrate low-cost precursor reconnaissance of prospective human exploration targets. The primary instrument payload will be a visible camera with color filters to collect data regarding the mineralogical, physical, and geotechnical properties of a candidate NEA for potential future robotic and human surface missions. The NEA Scout mission concept would be treated as a secondary payload on the Space Launch System (SLS) Exploration Mission 1 (EM-1), characterizing a Near Earth Object (NEA) relevant to future human exploration

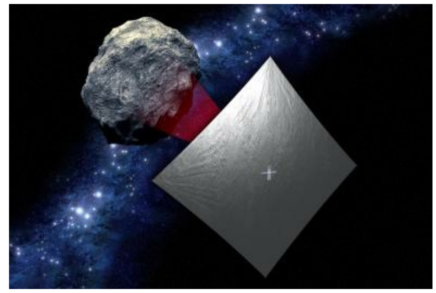
ANTICIPATED BENEFITS

To NASA funded missions:

Solar sails will be used to provide the primary propulsion for the NEA Scout and the Lunar Flashlight missions which are funded by the Advanced Exploration Systems Division of the Human Exploration and Operations Mission Directorate. Both missions will be launched as secondary payloads from the SLS EM-1 flight.

To NASA unfunded & planned missions:

Solar sails provide a new capability for delivering science payloads to planetary bodies, small solar system bodies, the outer solar system, non-Keplerian orbits, or a solar polar orbit.



Conceptual Design of NEA Scout Mission

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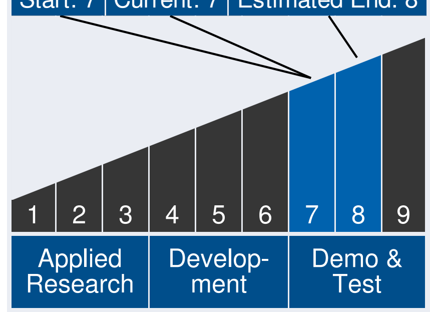
Technology Maturity

Start: 7 | Current: 7 | Estimated End: 8



Management Team

Program Director:

- Jason Crusan

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Using the continuous low thrust provided by a solar sail, spacecraft can obtain DV's that are impossible to achieve using chemical or even solar electric propulsion. As the technology matures, solar sails will increasingly be used to enable science and exploration missions that are currently impossible or prohibitively expensive using traditional chemical and electric rockets.

To other government agencies:

Other government agencies with the need to deploy small robotic spacecraft into low Earth orbit (LEO) or beyond Earth orbit (BEO) and/or deorbit spacecraft from LEO can benefit from the use of solar sails. Solar sails provide a highly efficient method to provide thrust and perform a wide range of advanced maneuvers, such as to hover indefinitely at points in space, or conduct orbital plane changes more efficiently than conventional chemical propulsion.

To the commercial space industry:

The NEA Scout project will lead to the design and development of optical measurement systems for planetary observations and solar sails for robotic missions, which can enable future commercial development of CubeSat class payloads.

To the nation:

The NEA Scout project can lead to affordable means to monitor Near Earth Asteroids that could be a threat to Earth.

DETAILED DESCRIPTION

Near-Earth asteroids (NEAs) are the most easily accessible bodies in the solar system, and detections of NEAs are expected to grow exponentially in the near future, offering increasing target opportunities. As NASA continues to refine its plans to possibly explore these small worlds with human explorers, initial reconnaissance with comparatively inexpensive robotic precursors is necessary. Obtaining and analyzing relevant data about these bodies via robotic precursors before committing a

Management Team *(cont.)*

Program Executive:
- Jitendra Joshi

Project Manager:
- Leslie Mcnutt

Technology Areas

Primary Technology Area:
In-Space Propulsion Technologies (TA 2)
└─ Non-Chemical Propulsion (TA 2.2)
  └─ Solar and Drag Sail Propulsion (TA 2.2.2)
    └─ Solar Sail Propulsion (TA 2.2.2.1)

Secondary Technology Area:
Science Instruments, Observatories, and Sensor Systems (TA 8)

crew to visit a NEA will significantly minimize crew and mission risk, as well as maximize exploration return potential.

In considering targets for human asteroid missions, there are several major factors that will make a significant difference in assessment of mission risks that can be addressed by simple photo-reconnaissance of a target. One of the most important of these factors is the spin state of the asteroid: does it rotate in a slow, easily predictable way? Asteroids that rotate very rapidly or that tumble about multiple axes present significant hazards in planning and executing proximity operations– especially operations that must be carried out over extended time periods. Another consideration is the physical state of the asteroid itself: is it a coherent mass or does it consist of a gravitationally bound pile of much smaller pieces? A coherent structure is unlikely to rearrange its configuration in response to a push by an astronaut or a hardware deployment and will provide a much easier surface in which to plant anchors for astronaut mobility or to hold equipment to the surface than will a rubble pile.

The full success criteria entails flying by a near Earth asteroid and acquire images sufficient to determine the target volume, shape model, Asteroid spectral type and meteorite analogs, rotational properties (pole position, rotation period), orbit, debris/dust field in local environment, and regolith characteristics.

Meeting this requirement addresses the need to fill Strategic Knowledge Gaps (SKG’s) related to asteroids as a precursor to subsequent safe and successful human missions. The data obtained will also support the advancement of science interests in asteroids.

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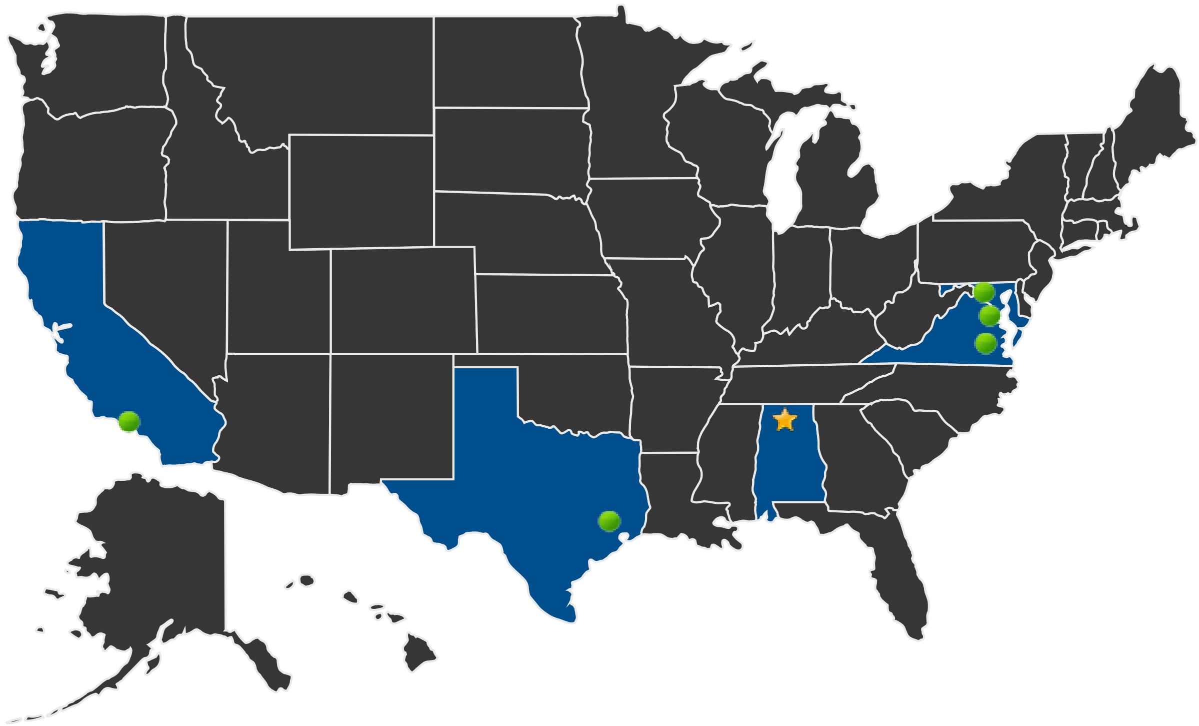
U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Marshall Space Flight Center

Supporting Centers:

- Goddard Space Flight Center
- Jet Propulsion Laboratory
- Johnson Space Center
- Langley Research Center
- NASA Headquarters

PROJECT LIBRARY

Videos

- Untitled
  - (https://www.youtube.com/watch?v=oGKry-AmV-c)

DETAILS FOR TECHNOLOGY 1

Technology Title

Solar Sail Propulsion

Technology Description

This technology is categorized as a hardware subsystem for unmanned spaceflight

Solar sail propulsion uses sunlight to propel vehicles through space by reflecting solar photons from a large, mirror-like sail made of a lightweight, reflective material. The continuous photonic pressure provides efficient primary propulsion, without the expenditure of propellant or any other consumable, allowing for very high delta velocity maneuvers and long-duration deep space exploration. Because the Sun supplies the necessary propulsive energy, solar sails require no onboard propellant (other than for attitude control), thus reducing payload mass.

NASA begain investing in solar sail technology in the late 1990's with significant progress being made toward their demonstration and implementation in space. Two 20m solar sail systems were developed by NASA and underwent rigourous testing under simulated space conditions. The NanoSail-D project deployed a subscale sail from the Fast Affordable Science and Technology SATellite (FASTSAT) in 2010. The Sunjammer project is in development and will unfurl a 38m and demonstrate dolar sail propulsion and navigation as it flies to L1.

Capabilities Provided

Solar sails provide a new capability for delivering science payloads to planetary bodies, small solar system bodies, the outer solar system, non-Keplerian orbits, or a solar polar orbit. Using the continuous low thrust provided by a solar sail, spacecraft can obtain DV’s that are impossible to achieve using chemical or even solar electric propulsion.

Potential Applications

As the technology matures, solar sails will increasingly be used to enable science and exploration missions that are currently impossible or prohibitively expensive using traditional chemical and electric rockets. In addition to using solar sails to provide the primary propulsion for robotic spacecraft, techniques are being explored to use solar sails for spacecraft attitude control as well, completely eliminating the need to carry any propellant on-board the spacecraft. Also, there is the potential of using solar sails as drag sails to increase the aerodynamic drag on low Earth orbit (LEO) spacecraft, providing a lightweight and relatively inexpensive approach for end-of-life deorbit and reentry.

Performance Metrics

Metric	Unit	Quantity
Mass	1	14 Kg
Volume	1	6 Liters